AN EXPLORATION OF THE INTERACTION BETWEEN SPEECH RATE, GENDER AND COGNITIVE STYLE IN THEIR EFFECT ON RECALL

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Abstract

This paper explores how the interaction between cognitive style, gender and type of task predict task outcome, particularly when presentation speed is varied. A sample of 91 11-year-old pupils the Cognitive Style Analysis. Pupils were assigned to one of two groups balanced for gender and cognitive style. Group 1 listened to a recording of a passage presented at 84wpm; group two listened to the same passage at 197wpm. Pupils were then required to comprehend and recall information from the passage that required assimilation of distantly positioned information. *Male verbalisers* and female imagers performed well in the slow condition but poorly in the fast condition. *Female verbalisers* showed improved performance in the fast condition. Results indicated that the interaction between verbal imagery style and gender predicts the outcome of verbal tasks, especially when processing speed was restricted. These results support differences in information processing between genders and also suggest that this processing is mediated by verbal imagery cognitive style.

Keywords: Cognitive Style, Processing Speed, Gender, Verbal Imagery, Information-processing

This paper considers cognitive style and its interactions with gender for mediating task outcome. In particular it investigates the effect of reductions in processing time for a verbal comprehension task and its effect on outcome for different cognitive style by gender groupings. This study builds on an initial study by Riding and Vincent (1980) that demonstrated that males and females processed information differently when assimilating distantly linked verbal material presented at differing speeds. The original study did not assess cognitive style or any interactions that cognitive style may have had with gender which may be an important factor in explaining why males and females process information of this type differently. More recently studies have indicated that cognitive style, namely verbal imagery style and gender interact differently for different tasks to mediate outcome (Riding & Armstrong, 1982; Riding & Boardman, 1983; Riding & Borg, 1987; Riding & Cowley, 1986; Riding, Dahraei, Grimley & Banner, 2001; Riding & Egelstaff, 1983; Riding & Rigby-Smith, 1984). In addition, this paper assimilates neuropsychological findings for cognitive style and gender differences in an attempt to explain these interactions.

Cognitive Style and its Assessment.

Riding and Rayner (1998) define cognitive style as “an individual’s preferred and habitual approach to organising and representing information” (p11). Cognitive style can be viewed as a relatively stable and fixed attribute of an individual, which is mirrored by individual brain correlates for individuals of differing styles (Glass and Riding, 1999; Riding, Glass, Butler & Pleydell-Pearce, 1997; Riding, Glass & Douglas, 1993). Riding and Cheema (1991) and Riding and Rayner (1998) suggest that style can be described by two distinct dimensions and that these dimensions reflect a number of style labels conceptualised within the literature. These style dimensions are assessed using the Cognitive Style Analysis (CSA) (Riding, 1991) and comprise:

- *The Verbal Imagery dimension*: describing the way an individual is inclined to represent information during thinking, either verbally or in mental pictures

- *The Wholist Analytic dimension*: describing the way an individual tends to organise information into wholes or parts

A number of researchers have questioned the reliability and validity of the CSA, on the grounds of its test-retest reliability, especially the verbal imagery dimension (see Massa & Mayer, 2005; Parkinson, Mulally & Redmond, 2003; Peterson, Deary & Austin, 2003; Rezai & Katz, 2004). However, it is argued that problems with the instrument's test-retest attributes are inconsequential given the overwhelming evidence for its validity (see Riding & Rayner, 1998 for instance). In addition, the majority of studies investigating its reliability failed to comply with Riding's guidelines for time between test and retest (Peterson, Deary & Austin, 2003; Riding, 2000) and some of these studies used atypical populations and small sample sizes (Parkinson, Mulally & Redmond, 2003). Other studies have supported the reliability of the wholist-analytic dimension (Evans & Waring, in press). Finally, Riding, R. J. (personal communication, October 10, 2005) on this issue suggests that the CSA is both valid and reliable but only on its first presentation.

Neuropsychological Evidence for Cognitive Style Differences

Riding et al, (1997) believe that cognitive style has a physiological basis. Riding (1996) suggests there is a dominance effect between left and right hemispheres for the verbal imagery dimensions. Studies investigating whether cognitive style differences are reflected in differences in localised activity in the brain using EEG measures indicate a relationship between cognitive style and brain activity (Glass & Riding, 1999; Grimley, 2002; Riding, et al., 1997). Results from a cohort of right handed individuals (9 male, 6 female) showed that verbalisers have more alpha suppression on the left side of the brain with the reverse true for imagers (Riding et al. 1997). Theta, gamma, delta, beta 1 and beta 2 all showed increased power on the right for verbalisers compared to imagers (Glass & Riding, 1999). These results support Riding's (1996) postulate of verbalisers being more active on the left and imagers on the right.

Gender and Information-processing

Studies have indicated that males and females differ in their information-processing approach for particular tasks. Riding and Vincent (1980) conducted a study looking at boys and girls of ages 7, 10, 12 and 15 years and found that females of all ages were poorer at recalling prose passages with information positioned distantly, thus requiring assimilation, when speech rate was increased compared to males of all ages. Similarly, Riding and Smith (1981) found that females improved recall when a passage was repeated as opposed to males whose recall declined. This improvement in recall for females was enhanced by a slow speech rate. Riding (1998) suggests that this is a fundamental difference in information-processing between males and females. Specifically, males process to a superficial level whereas females process to a much deeper level as in the Riding and Vincent (1980) study. Thus, females use their slower processing abilities to consolidate information when the passage is repeated; on the contrary, males process on a superficial level and fail to consolidate information which may lead to interference.

Riding and Egelstaff (1983) asked pupils to read through a prose passage about volcanoes several times in an attempt to remember it. They were then given the same passage with a number of word changes and asked to circle any words they thought had been changed. Four types of word change were incorporated into the final passage, these were; *image change and meaning change; image same but meaning change; image change but meaning same* and *image same and meaning same*. Results indicated an interaction between image change, meaning change and gender. Males and females showed similar detection rates for words that showed little image change. However, a cross over effect was seen between males and females for words that had changed their image, with males detecting more words that had also changed meaning with females showing the reverse. Consequently, boys appeared to be more affected than girls if both the meaning and image changed. This may indicate different processing mechanisms for boys compared to girls. However, little is known about why these outcomes are observed and given that cognitive style differences seem to be reflected in brain differences, it would seem reasonable to assume that these brain differences may be interacting with other individual differences within the brain to mediate the outcome of specific tasks.

Neuropsychological Evidence for Gender Differences

Gender differences in information processing are reflected by male-female brain differences (Bradshaw & Nettleton 1983; Udry 1994) and research has indicated that males and females differ in terms of functional cortical geometry (Goldberg et al. 1994; Kimura, 2004; Levy & Heller 1987) influenced by hormonal differences in-utero (Halpern 2001; Kimura 1996; Udry 1994; 2004). More specifically female brains have been shown to have larger language associated areas than males and increased verbal processing capacity in the right hemisphere compared to males (Annett 1991; Harasty, Double, Halliday, Kril & McRitchie, 1997). Studies have consistently reported that the degree of lateralisation is less in females than in males (Kansaku & Kitazawa, 2001; Levy & Gur, 1980; McGlone, 1980; Shaywitz, et al, 1995). Shaywitz et al (1995) using functional magnetic resonance imaging reported that for phonological tasks male brains are more lateralised than female brains. Male brains showed a predominantly left-brain response but female brains showed a much more diffuse neural pattern.

Studies showed strong between hemisphere (inter-hemispheric) functional interaction in women and strong within hemisphere (intra-hemispheric) functional interaction in men (Azari, Pettigrew, Pietrini, Murphy, Horwitz & Schapiro, 1995; Corsi-Cabrera, Arce, Ramos, Guevara, 1997; Kocel; 1980; Wood, Flowers & Naylor, 1991). These differences may enable women to excel on tasks which require co- operation of both hemispheres but this may precipitate poor performance for tasks requiring intra-hemispheric co-operation such as spatial tasks or uni-hemispheric co-operation tasks. Men are more likely to perform well for tasks that rely on intra-hemispheric co-operation. Azari et al (1995) presented some exploratory findings suggesting that patterns of neuropsychological asymmetry for men and women tend to be reversed for a number of neuropsychological tasks. These results indicated that men and women showed sex differences in right relative to left hemisphere function. This may reflect reversal effects seen in style by sex by task interactions in the cognitive styles literature (e.g. Riding & Armstrong, 1982; Riding & Boardman, 1983; Riding & Borg, 1987; Riding & Cowley, 1986; Riding, Dahraei, Grimley & Banner, 2001; Riding & Egelstaff, 1983; Riding & Rigby-Smith, 1984). These interactions are discussed below.

Gender by Cognitive Style Interactions

Gender and cognitive style have been shown to interact to mediate task outcome (Riding & Armstrong, 1982; Riding & Boardman, 1983; Riding & Borg, 1987; Riding & Cowley, 1986; Riding, Dahraei, Grimley & Banner, 2001; Riding & Egelstaff, 1983; Riding & Rigby-Smith, 1984). These interactions tend to involve gender and the verbal imagery dimension with outcome varying according to type of task performed.

Riding and Armstrong (1982) considered pupils' performance on three mathematics tests of computation, spatial relations and length. Results indicated an interaction with gender and style. The results for the computation test showed a classic reversal of attainment between boys and girls of the same verbal imagery style. Bimodal boys[1] attained high scores, much higher than scores obtained by their verbaliser and imager counterparts who both showed equally low scores. The verbalisers and the imagers obtained the highest scores for females with bimodal girls performing poorly, which is opposite to the results for the boys. Another study confirmed these results and differentiated between computation type by considering multiplication, addition, subtraction and division (Riding & Borg, 1987). Findings in this study indicated that the same trends, as seen in the Riding and Armstrong study, were evident for each computation method. Riding and Armstrong (1982) suggested that boys tended to encode and process information best when it corresponded with the type of processing most suited to their particular style, but that this was not true of girls. Results for the spatial test indicated that bimodal males performed better than male imagers, who in turn performed better than *male verbalisers*. Contrary to the findings for boys on the spatial test *female verbalisers* showed the best performance, closely followed by *bimodal females* with *female imagers* giving the worst performance. These results indicated that males and females show another reversal effect. Results for the length test indicated that male verbalisers and bimodal males showed the best performance with male imagers performing poorly. Females showed the best attainment for the imager and bimodal styles with the worst attainment being for the verbaliser, thus indicating another reversal between males and females. Riding and Armstrong (1982) argued that length is best represented using verbal coding and that spatial relation is best represented in images. If this is true then it appears that boys excel if their verbal imagery style suits the encoding strategy best employed for the particular task being performed. From this premise it follows that bimodal styles are better suited to computation than verbal or image based encoding. It is likely that computation takes the form of both verbal and image based systems. However, female information processing is much harder to explain because the expected verbal imagery style suitable for a particular task appears not to produce the best results.

[1] Verbal Imagery style is sometimes split into three grouping verbaliser, bimodal and imager.

Riding and Egelstaff (1983) asked pupils to read through a prose passage about volcanoes several times in an attempt to remember it. They were then given the same passage with a number of word changes and asked to circle any words they thought had been changed. Four types of word change were incorporated into the final passage, these were; *image change* and *meaning change*; *image same but meaning change*; *image change but meaning same* and *image same and meaning same*. Results indicated an interaction between image change, meaning change and gender. Males and females showed similar detection rates for words that showed little image change. However, a cross over effect was seen between males and females for words that had changed their image, with males detecting more words that had also changed meaning but girls showing the reverse. Consequently, boys appeared to be more affected than girls if both the meaning and image changed. This may indicate a different processing mechanism for boys compared to girls. It should however be noted that it is difficult to change the meaning of a word without also changing its image and vice-versa. The material did not always satisfactorily achieve its aims here. Furthermore, an interaction between gender, verbal imagery style and image change indicated a reversal effect between males and females for different styles for the image change word detection. Male imagers showed a better detection rate than male verbalisers. Females showed the reverse of this with female verbalisers having the best performance. Males and females showed a similar pattern of change detection for the *no image change* words with verbalisers showing the greatest detection rate. We would expect that imagers should perform better when words change image and this seems to be true for the males. These results correspond with the results found in the mathematics studies cited previously (Riding & Armstrong, 1982; Riding & Borg, 1987), in that males tended to perform best when their verbal imagery style was suited to the task, whereas females showed the opposite trend.

Riding and Rigby-Smith (1984) gave 7-year-olds two 500-word passages of equal difficulty to read aloud and the experimenter assessed their competency for the reading of different word types. One of the passages was read in one continuous sitting whereas the other was read in five instalments. Results indicated that better reading accuracy was obtained for the passage read in instalments and that there was a further three way interaction between word complexity, gender and verbal imagery for reading accuracy. This interaction showed a reversal of results for males and females on both short words and long words. For short words the effect was much less pronounced than for long words and showed little difference between imagers and verbalisers. The effect for long words showed that *male imagers* performed poorly and *bimodal males* performed well with verbalisers somewhere in the middle. The opposite was true for females with verbalisers showing the best performance. This result shows a reversal effect between males and females, once again.

Riding and Cowley (1986) assessed 7-8-year-old pupils on three reading tests. The reading tests were different by virtue of the amount of context the task provided and the type of task performed. Test one required pupils to read aloud lists of words that got progressively more difficult until they had made a number of mistakes. Test two required subjects to read a sentence and insert a word within that sentence from a list of given words. Test three required subjects to read a passage for understanding and to answer eight comprehension questions about the passage. This final version used two tests of differing difficulty, easy and hard. Results indicated that for all three tests, *male verbalisers* excelled and *male imagers* performed poorly. The reverse was true for females. The results for males showed results consistent with their verbal imagery style with verbalisers doing well for the verbal based tests and imagers doing poorly. Females showed results that indicated that imagers performed better for reading tests, although one would expect the reverse characteristics according to their style. The results for these reading tests in terms of the style by gender interactions showed similar trends to the other studies presented above e.g. males performed as predicted by their verbal imagery style and females showed the reverse characteristics.

Riding and Boardman (1983) tested pupils on a map reading exercise designed to measure three aspects of map reading. The three types of map reading were as follows:

- Map-Aerial Photo Correlation, which entailed the pupil being required to name objects on a map from a photo and vice-versa.
- Symbol Translation, which entailed the pupil identifying symbols in a given area of a map and writing down their meaning from the key given.
- View Identification, entailed the pupils identifying the view they would see from a place on the map from a selection of photographs.

Results indicated a style by gender interaction for map-photograph correlation and view identification. Where boys of a particular verbal imagery style showed a superior performance but girls showed an inferior performance. When the expected level of expertise was estimated considering the pupils' cognitive style females performed as expected whereas males performed in the opposite way. These results are contradictory to those found by the majority of studies cited above where the general trend was for males to follow the pattern typical of their verbal imagery style. In this study the opposite was true. The content of the task itself may mediate the type of gender by style interaction produced. If the content of the task for this study is analysed it may be concluded that the tasks are spatial imagery tasks. However, tasks in the previous studies were either verbal or numerically based (Riding & Armstrong, 1982; Riding & Borg, 1987; Riding & Cowley, 1986; Riding & Dyer, 1983; Riding & Egelstaff, 1983; Riding & Rigby-Smith, 1984).

Riding, Dahraei, Grimley and Banner (2001) observed, for Maths and English attainment, an interaction between gender, verbal imagery style and working memory efficiency. Results indicated reversal patterns between males and females for the same verbal imagery styles. For mathematics, males showed a convergence from verbalisers to imagers; low memory verbalisers performed worst, but high memory verbalisers performed best. Contrary to the male results, *female imagers* performed best for both high and low memory. For English the convergence was seen for females. Low memory imagers performed better than verbalisers, but the reverse was true for high memory subjects. Males, however, showed a superior performance for verbalisers for both memory types. These effects could be described by fundamental differences between males and females in information processing. In the present study the style groupings were split into two, but if they had been split into three they may have shown similar results to that of Riding and Armstrong (1982). Additionally, English results (verbal in nature) show the typical strength for males who are verbalisers for both working memory levels. However, for females, working memory seemed to mediate the verbal imagery effect with low working memory suited to imagers (as expected from previous studies) but high working memory suited to verbalisers.

The type of task that mediates outcome for different gender by style interactions seems to correspond with recognised areas of cognitive ability, namely, verbal, spatial and quantitative ability (McGuinness, 1998). These types of task also correspond with recognised cognitive gender differences (Halpern, 2001).

When the task is verbal *male verbalisers* perform well but females show the reverse pattern with *female imagers* performing best. Males are thus performing as they would be expected to according to their verbal imagery style characteristics. In other words *male verbalisers* perform best for these verbal tasks with the reverse being true for females (Riding & Armstrong, 1982; Riding & Cowley, 1986; Riding & Rigby-Smith, 1984; Riding et al, 2001). For visuo-spatial tasks *female imagers* perform best compared to *female verbalisers*, whereas *male verbalisers* perform better than *male imagers*. This is the reverse pattern of that seen for the verbal tasks (Riding & Boardman, 1983; Riding & Egelstaff, 1983). Quantitative tasks show a different gender by verbal imagery interaction pattern with *bimodal males* performing best compared to *male verbalisers* and imagers. However, females show the reverse characteristics with *female bimodals* having the worst performance and *female verbalisers* and imagers the best performance (Riding & Armstrong, 1982; Riding & Borg, 1987).

Clearly, these studies demonstrate that their is a link between learning outcome measures and interactions between gender and cognitive style for particular tasks, therefore there is a clear need for further investigations to be carried out to ascertain the exact nature of these interactions and how they relate to the learning task.

This study revisits Riding and Vincent's (1980) original experiment to explore how gender and cognitive style interact with a verbal comprehension task. Firstly, the study incorporates cognitive style, which the original study failed to do, to ascertain whether it was a style by gender interaction that was instrumental producing the gender information processing differences observed in the original study. In addition, the verbal comprehension task is manipulated so that processing time is varied. In condition one processing time is plentiful and allows sufficient processing time for the task in hand. In the other condition processing time is reduced.

Method

Participants

Two urban primary schools in the UK agreed to take part in the study. The participants were 91 pupils of mixed ethnicity from Year 6, 54 boys and 37 girls, comprising 61 pupils from School 1 and 30 pupils from School 2. School 1 had two classes of pupils in Year 6, 30 and 31 pupils in each of the classes. All pupils were included in the testing. School 1 also had two classes in Year 6, however, only one Year 6 class, containing 30 pupils was included in the study. Pupils were aged between 10 and 11 years of age with male pupils having a mean age of 10.69 years (SD. 0.47) and females 10.70 years (SD. 0.46). This age range was chosen so as to be within the mid range of that used in the Riding and Vincent (1980) original study which used pupils of ages 7yrs, 10yrs, 12yrs and 15yrs.

Cognitive Style Analysis

All participants were assessed individually for their cognitive style using the Cognitive Styles Analysis (Riding, 1991). The Cognitive Style Analysis (CSA) (Riding, 1991) is a computerized test that can be used effectively with children as young as seven and takes only 10–15mins to complete. The test measures both ends of each dimension (verbal imagery, wholist analytic) and generates a ratio score for each dimension as well as a verbal label for the style measurements. The first of three subtests assesses the verbal imagery dimension by presenting statements one at a time on a computer screen. Respondents are required to decide whether each statement is true or false by pressing a key labelled true or a key labelled false. Half of the statements are true and half are false, there are 48 statements in total. The statements ask whether two items belong to the same semantic category (e.g. beans is the same as chicken) or whether two items are similar in appearance (e.g. cheese and custard are the same colour). The time taken to respond to each of the questions is recorded. Verbalisers should be quicker than imagers to answer items asking them to respond to abstract semantic categories because the statement cannot be converted into a visual form. Imagers should respond quicker when presented with concrete decisions that enable them to image the statement. When participants have responded to all items, a ratio is calculated for the average response time of the verbal questions and imagery questions. A low ratio (e.g. below 1.00) corresponds to a verbaliser and a high ratio (e.g. above 1.00) corresponds to an imager. The second sub-test directs users to decide whether two complex geometrical figures are the same or different and comprises 20 items. This is thought to assess wholist ability because the respondent is required to compare the whole shapes to make a decision. The third and final sub test assesses analytic ability. The respondent is asked to judge whether a simple geometric shape is part of a more complex geometric shape and again comprises 20 items. This assesses analytic ability because the respondent is required to break down the complex figure in order to make his/her decision. Following completion of these two subsets the response times are averaged and a ratio is produced for the wholist analytic ratio. Respondents with a low ratio are judged to be wholists and respondents with a high ratio are judged to be analytics.

Respondents are not informed that their reaction times are being assessed. Therefore they are given as much time as they wish to respond to each statement. Additionally, incorrect answers do not influence the measurement of style, because wrong answers are not taken into account, the test merely assesses the amount of time taken to respond to each statement. The test provides the respondent with a ratio score for each dimension along with a label for their combined style.

Pupils were tested in groups of two to three using three personal computers with colour monitors. Scores on the verbal imagery scale and wholist analytic scale were obtained. The overall mean for the wholist analytic dimension was 1.20 (SD=0.49) with range of scores between 0.61–2.92 and the mean for the verbal imagery dimension was 1.08 (SD=0.17) with range of scores between 0.77-1.71. A correlation between the ratios showed a non-significant correlation coefficient of $r = .12$, thus indicating independent cognitive style dimensions. A one way analysis of variance of the two dimensions with gender as the independent variable showed no significant differences for either dimension, indicating that both dimensions were independent of gender. Participants were split between groups and balanced for verbal imagery style and gender using a median split technique for the verbal imagery data, subsequent cognitive style divisions were: *Wholist-Analytic dimension*: Wholist, 0.61-1.00

(37; 25 males, 12 females); Analytic. 1.01-2.92 (54; 29 males, 25 females): *Verbal Imagery dimension*: Verbaliser, 0.77-1.06 (46; 27 males, 19 females); Imager, 1.07-1.71 (45; 27 males, 18 females).

Materials

The learning materials were a 285-word passage (Appendix 1) about the natural history of the salmon, taken from Riding and Vincent's (1980) original paper. The passage containing distantly positioned details was chosen and recorded on audiotape at either 84wpm (slow presentation rate) or197wpm (fast presentation rate), normal speech rate being approximately 150wpm. A recall test of 12 questions (see Appendix 1) was used, taken from the original paper. The questions could only be answered by assimilating information from different parts of the passage.

Procedure

Pupils were randomly allocated to two groups controlling for gender and cognitive style (based on the verbal imagery dimension), thus obtaining relatively equal distributions of males and females within the four style groupings (see Table 1). The participants were asked to listen very carefully to the pre-recorded passage through headphones and told that they would be required to answer questions about the passage later. Group 1 were given the slow presentation of the passage and Group 2 were given the fast presentation of the passage. Immediately following presentation, pupils were handed a piece of paper with spaces for the answers to 12 questions and a space for their name. The experimenter, who was male, then asked the participants questions one to twelve in order. They were given sufficient time to write down the answer. Participants were tested in groups of 3 or 4.

TABLE 1 HERE

Results

A four-factor analysis of variance was carried out on the salmon data, the results of which are shown in Table 2. The independent variables were gender (2), verbal imagery style (2), wholist analytic style (2) and presentation speed (2). The dependent variable was the number of questions answered correctly, with a maximum score of twelve and a minimum score of zero. An alpha level of .05 was used for all statistical tests.

TABLE 2 HERE

There were three significant effects. A main effect of presentation speed ($F(1,75)=13.64$, $P<0.0001$), a two way interaction between verbal imagery style and presentation speed ($F(1,75)=5.68$, $P=0.02$) and a three way interaction between gender, verbal imagery style and presentation speed ($F(1,75)=16.87$, $P < 0.0001$).

The main effect of presentation speed shows that pupils who received the slow passage performed better overall than the pupils who received the fast presentation (slow presentation $M=5.00$, $SD=2.77$; fast presentation $M=3.14$, $SD=1.88$; $d=0.8$). The two-way interaction verbal imagery style and presentation speed is subsumed by the three way interaction which is shown in Table 3.

TABLE 3 HERE

The three-way interaction is also shown in Figure 1. In the slow presentation condition male verbalisers scored higher than male imagers, however in the fast presentation condition male imagers scored higher than male verbalisers. Females demonstrated the opposite characteristics for both fast and slow presentation speeds with imagers performing best in the slow presentation condition and verbalisers performing best in the fast presentation condition. Post-hoc t-tests reveal that within the male grouping only the difference between the slow and fast conditions for verbalisers was significant. However, females showed significant differences between verbalisers and imagers in the slow and fast conditions and between imagers in the slow and fast conditions (see Table 3). Female imagers and male verbalisers showed effect sizes of 2.23 and 1.61 respectively. In addition, there were large effect sizes (1.33, 1.37) between styles for females within each presentation condition. Most groupings reduced their performance between the slow condition and the fast condition. However, female verbalisers increased their performance from the low condition to the fast condition.

FIGURE 1 HERE

Discussion

Results of this study showed that both gender and verbal imagery cognitive style influenced the outcome for this verbal task as predicted. This appeared to be the case whether the presentation speed was high or low. Females with the same verbal imagery style as males processed the same information differently. Increases in presentation speed decreased performances for **male verbalisers**. However, this did not hold for *female verbalisers* who increased their performance when presentation speed increased. In the slow presentation condition female imagers performed well compared to their verbaliser counterparts but this was reversed for males. In the fast presentation condition *female verbalisers* performed well compared to *female imagers* but again this was reversed for males.

Previous studies (Riding & Armstrong, 1982; Riding & Cowley, 1986; Riding & Rigby-Smith, 1984; Riding et al, 2001) that have shown interactions between gender and verbal imagery style for verbal tasks have indicated that *male verbalisers* do well, as do female imagers. This study indicates that this may only hold true for verbal tasks that allow sufficient processing time, with the reverse effect being observed when processing time is reduced or restricted.

It is clear from the data presented in this study that presentation speed is a vital factor when predicting the outcome of a verbal task such as this but more importantly the outcome differential is dependant upon the gender and the verbal imagery style of the individual engaged in the task. It is evident that increasing the speed of presentation for *female imagers* could be potentially catastrophic for their performance, similarly this holds true for *male verbalisers* but to a lesser extent.

One unexpected trend within this study was that increasing the presentation speed (or reducing processing time) seemed to improve the performance of *female verbalisers*. Riding (1998) suggested that males and females appear to differ in terms of their information processing. However, further to Riding's original supposition this processing appears to be mediated by cognitive style, particularly verbal imagery style. In addition, Riding suggests that males process to a superficial level whereas females process to a much deeper level. Data presented in this study challenge this assertion, especially for *female verbalisers* who appear to perform best under reduced processing time. Similar effects were seen in the Riding et al (2001) study where working memory mediated verbal task outcome across genders with *female verbalisers* performing best if they had high working memory characteristics but *female imagers* performed best under low working memory conditions. Males however showed that the verbaliser style was best for both high and low working memory levels.

Reducing processing time (fast condition) in this study may equate to a reduced working memory capacity in the Riding et al (2001) study, but further work is needed to clarify this.

Neuropsychological evidence (Azari et al, 1995; Corsi-Cabrera et al, 1997; Goldberg et al, 1994; Levy & Heller, 1987; Kocel; 1980; Wood et al, 1991) also points to processing differences between males and females with females having the flexibility to shift processing between hemispheres. These underlying brain differences are also supported here with the behavioural evidence suggesting that gender brain differences may be interacting with cognitive style brain differences (Glass & Riding, 1999; Grimley, 2002; Riding, et al., 1997) to mediate outcome for different educational tasks.

It would be prudent to investigate non verbal tasks (Riding & Boardman, 1983; Riding & Egelstaff, 1983) and quantitative tasks (Riding & Armstrong, 1982; Riding & Borg, 1987) in a similar manner based on evidence form the literature. In addition, studies that utilise physiological measures such as EEG or fMri are warranted to ascertain brain correlates of such behavioural studies so that the underlying processing can be identified.

The results of this study have implications for the measurement of cognitive style. At present cognitive style can only predict a small percentage of the variance for task outcome. However, as demonstrated here, the outcome of the task is also dependent upon gender. Therefore the cognitive style analysis and its predictions for learning tasks may be different for different users, in this case different genders. More exploration is needed. The large effect sizes shown in this study indicate that further exploration is essential as they reflect real effects and real learning advances for individuals could be uncovered. If the cognitive mechanism for style by gender interactions were to be better understood this would enable educators to predict with more accuracy the outcome of certain learning tasks and equip educators with the understanding to adapt tasks to suit the individual learner. Clearly, if instructional strategies are to be effective more information is required about how individual differences such as cognitive style and gender affect learning outcome. With further exploration efficient individual learning plans could be implemented by taking into account a person's cognitive style, gender and possibly their working memory capacity. With the advent of new media this type of individual instruction is becoming a reality rather than a possibility and it is therefore essential that factors which could improve their design are explored thoroughly.

Finally, similar studies to this one should be carried out using improved verbal imagery instruments and some suggestions as how they might be improved are suggested by Rezai and Katz (2004). Also, gender by style interactions could be usefully explored with other cognitive style instruments.

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Table 1 Showing the N (frequency) of the Groupings by Gender and Cognitive Style

	Verbaliser	Imager	Wholist	Analytic
Male	27	27	25	29
Group 1 (text)	16	13	13	16
Group 2 (narrated)	11	14	12	13
Female	19	18	12	25
Group 1 (read)	9	9	5	13
Group 2 (narrated)	10	9	7	12

Table 2. ANOVA Results for Tests of Between-Subjects Effects

Source	df	F
Gender	1	.402
Wholist-analytic style	1	1.189
Verbal imagery style	1	1.222
Condition (fast vs slow)	1	13.643**
Gender x wholist analytic style	1	.026
Gender x verbal imagery	1	.814
Wholist Analytic style x Verbal Imagery style	1	.220
Gender x WA x Verbal Imagery style	1	1.829
Gender x condition	1	.758
Wholist Analytic style x condition	1	.157
Gender x Wholist Analytic style x condition	1	.010
Verbal Imagery style x condition	1	5.677*
Gender x Verbal Imagery style x condition	1	16.867**
Wholist Analytic style x Verbal Imagery style x condition	1	.395
Gender x Wholist Analytic style x Verbal Imagery style x condition	1	3.109
Error	75	(5.109)

Values enclosed in parentheses represent mean square errors. * indicates $p<0.05$, ** indicates $p<0.01$.

Table 3 Mean Number of Questions Answered Correctly for Different Speeds of Presentation for Males and Females of Different Verbal Imagery Style (with effect sizes [d] and post-hoc tests indicated).

	MALE			FEMALE		
	Verbalisers	Imager	'd '	Verbalisers	Imager	'd '
Slow Presentation	5.44 (3.03) n=16	4.77 (2.24) n=13	0.28	3.11 (2.76) n=9	6.44 (2.24) n=9	1.33*
Fast Presentation	2.27 (0.90) n=11	3.29 (2.13) n=14	0.67	4.60 (1.90) n=10	2.33 (1.41) n=9	1.37*
Effect Size (d)	1.61*	0.68		0.64	2.25*	

*Indicates that the difference indicated by the effect size is statistically significant below the 0.05 level, based on post-hoc t-tests

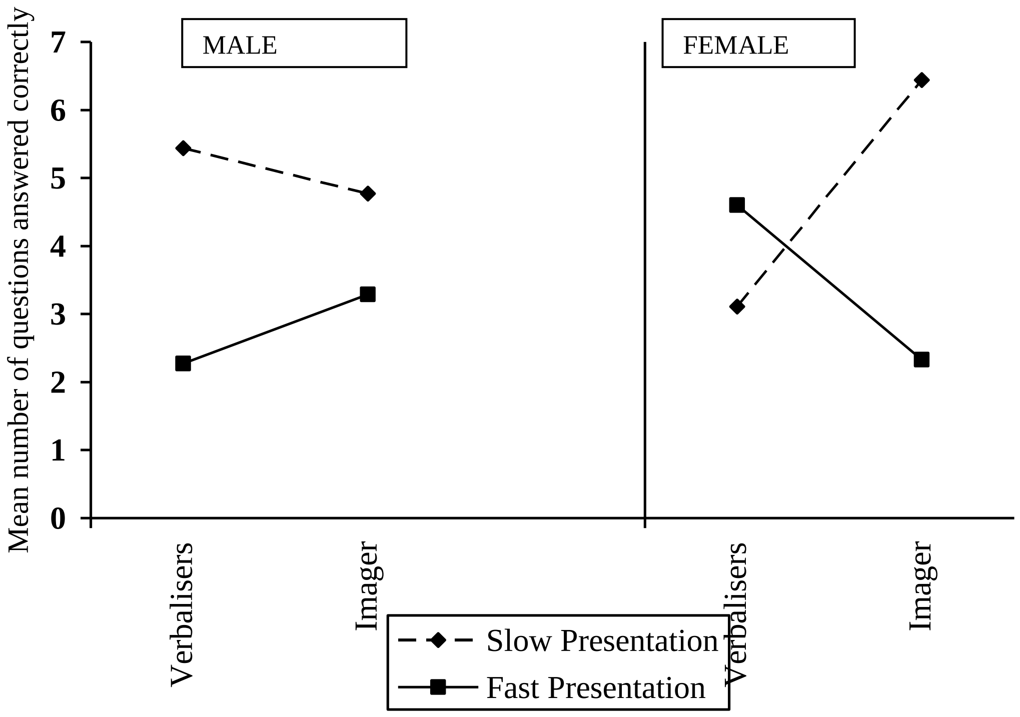

Figure 1 Graph to Show Mean Number of Questions Answered Correctly for Fast and Slow Presentation Speeds for Males and Females of Different Verbal Imagery Style

Appendix 1

The Life of the Salmon – Related details distantly positioned.

Today you are going to hear about a fish called the salmon. The life story of the salmon has always interested man although some of the ways of this unusual fish are still not understood.

The salmon spends most of its life in the sea. The mother salmon only leaves the sea to find a stream in which to lay her eggs. Salmon are able to find their way back to their own stream. The salmon then swims up its stream. Whilst swimming upstream the salmon has nothing to eat. The salmon stops when it reaches a sheltered pool. The salmon makes a hollow in the sand at the bottom of the pool. The eggs are then buried. Salmon which are old are called Kelts. Salmon eggs take about ninety days to hatch out. Young salmon have black patches called parr-marks. When it becomes silver in colour the salmon is fully grown.

The salmon spends most of its life where it can find plenty of food. The mother salmon leaves the sea to look for the stream in which she was born. Salmon are able to find their way by smelling the different kinds of water. The salmon may have to leap waterfalls. As it swims upstream it becomes thin and white. The salmon usually stops swimming upstream in October. The salmon can move sand by jerking her body. The eggs cannot be eaten by other fish. Kelts can no longer lay eggs. Newly born salmon are roughly one centimetre long. Parr marks are found on the side of young salmon. When it is fully grown the salmon is ready to return to the sea.

The fascinating story of the salmon then begins again.

Test questions for Salmon Passage

1. *Why does the salmon spend most of its life in the sea?*
2. *In which stream does the mother salmon lay her eggs?*
3. *How can salmon find their way to their own stream?*
4. *What may the salmon have to do as it swims upstream?*
5. *Why does the salmon become thin and white whilst swimming upstream?*
6. *What does the salmon usually reach in October?*
7. *How does the salmon make a hollow in the sand at the bottom of the pool?*
8. *Why are salmon eggs not eaten by other fish?*
9. *What can old salmon no longer do?*
10. *How big are the young salmon ninety days after the eggs have been laid?*
11. *Where are the black patches found on young salmon?*
12. *What colour is the salmon when it is ready to return to the sea?*